DOCUMENT RESUME

ED 304 130 IR 013 703

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TITLE Beyond the Star Trek Syndrome to an Egalitarian Future: "Where No One Has Gone Before." PEER Computer Equity Report.
INSTITUTION NOW Legal Defense and Education Fund, Washington, DC. Project on Equal Education Rights.
PUB DATE 86
NOTE 13p.; The Second in a Series of Computer Equity Reports.
AVAILABLE FROM PEER/NOW, 1333 H Street NW, Washington, DC 20008 ($5.00).
PUB TYPE Information Analyses (070) -- Viewpoints (120)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Computer Literacy; Computer Science Education; Elementary Secondary Education; Employment Patterns; *Equal Education; *Females; *Programing; Public Schools; *Sex Bias; *Sex Differences
IDENTIFIERS *Computer Equity

ABSTRACT

This examination of computer equity argues that current educational trends--which emphasize teaching applications of computers rather than programming--will limit the computer skills of students. Added to this difficulty is the argument that some students (often minority and female students) need not be pushed to learn programming if they don't wish to do so. It is suggested that a commitment to equal access requires that such choices, between applications and programming, should not be made for students based on their apparent lack of interest or sex-based stereotyping. Various strategies for breaking down the programming barrier are discussed, and the importance of advanced computer skills for jobs of the future is stressed. Three recommendations to enhance computer equity are made: (1) computer literacy instruction should be required for all students, and should include programming, applications, and discussions of the political and ethical issues surrounding the uses of technology; (2) all students should have equal access to computers both in school and at home; and (3) activities both inside and outside the classroom should be provided to overcome the effects of sex- and race-stereotyped assumptions about computers. (84 references) (EW)

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The Second in a Series of Computer Equity Reports

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The Star Trek Syndrome

On the bridge of the Starship Enterprise, Captain James T. Kirk presides over a carefully integrated crew—a 1960s flawed vision of the future that appears to be a model of racial justice and sexual equality. Along with talking computers and faster-than-light travel, the Enterprise attempts "to boldly go where no *man* has gone before" in portraying society in the twenty-third century. But this Star Trek future retains the biases of the 1950s; a look at the bridge of the Enterprise reveals a very old-fashioned social structure:

Captain Kirk is the Great White Father; not only is he the all-powerful captain of the starship, but he also is portrayed as a nearly infallible leader. Persons of color, of both sexes, usually occupy subservient positions; and the non-white male officers exemplify old-time racial and cultural stereotypes that reflect American biases of the 1950s. In fact, the only minority man in a position of leadership and authority is Mr. Spock—a Vulcan. He does not threaten white male dominance because he is from another planet; further, he is clearly seen as "inferior" because he is completely non-emotional or, as his friend the ship's doctor always reminds him—"not human."

Star Trek women are almost entirely in traditional roles—as handmaidens, love interests and window dressing. The only woman officer on the bridge, Lt. Uhura, is an African woman who serves as "communications officer"—a high tech telephone operator. Other women who appear resemble the 1940s and 50s stereotype of the bitter, dissatisfied career woman; although they may be doctors, lawyers, research scientists or planetary ambassadors, their lives are portrayed as empty and unfulfilled if they are not also wives and/or mothers.

The Star Trek future is a bleak one for women and persons of color, as the basic patterns of discrimination and bias persist despite all the advanced technological gadgets and gimmicks. Although women and persons of color participate in the future, they do not control it—decisionmaking and leadership remain in the hands of white men. Unfortunately, we will be on a direct course to such a Star Trek future unless we act today to ensure that all students have truly equal access to the whole range of computer-related educational experiences. Unequal access for today's students will produce tomorrow's "technopeasants," a permanent underclass of female and minority workers—the young women and men who today are computer "have nots," discouraged from excelling in math, science and technology education because of sex and race stereotypes and denied access to technology because of economic status.

Stories from the Equity Frontier

Every day individual women and girls are being discouraged, belittled and blocked when they attempt to open the doors to the magic kingdom of computers and technology. Only the bravest and most determined girl can overcome the barriers exemplified in the following actual cases:

- A superintendent in a midwestern school district, discussing the acquisition of computers for the junior high school, indicated that first priority for computer learning would be given to the boys, because they would "need to know about computers for their future careers, in engineering."
- A superintendent in a major urban school district in the east responded to charges of sex discrimination in the district's extensive computer education program by declaring that there was no sexism at all, because most of the students in word processing courses were female.
- In a school offering two similar elective courses, "Keyboarding" and "Personal Typing," counselors indicated that "Keyboarding" was designed for the "boys who were going to be taking programming and couldn't type." And the explanation for this sex segregation reflected sex biased assumptions: "Keyboarding presented skills neccessary for those students [male] who would be taking the computer programming classes—a course with math prerequisites offered as an advanced course in the math department—and these [male] students needed to keyboard if they were to get the most out of the programming class."
- A computer-using elementary school teacher who had received equity training reported that one of her young students kept refusing to take her turn on the computer. After several minutes of gentle but persistent questioning by the teacher, the girl admitted that she really wanted to work on the computer, but "the boys had said if she didn't give them her turn, they would hit her."
- A frustrated parent reported that her daughter's eighth grade math teacher reassured the parents about their child's lack of interest in math by saying: "Oh, she's such a pretty little thing. She'll get married at eighteen and won't need to know much math."
- Asked what she would use her computer for, a 12 year old girl said "I would ask my computer to find me a perfect husband. I would tell it to tell me where to find the prettiest clothes and tell me where to get my hair done."[1]
- In one northwestern school district, three girls and five boys enrolled in an advanced computer programming class, but there were only five computers available. On the first day of class the teacher told the boys to take seats at the computers and instructed the girls to sit in the back of the room, where they remained. During the second week of class, the mother of one of the girls asked her daughter how the computer course was going, and found out what had been happening. When the mother protested, the teacher was mystified. He believed that he

was doing these young women a favor because, he said, the girls prefer to sit in the back of the room where they can "gossip and giggle."

- A Roper poll conducted in 1984 asked adults about suitable careers for their children. While computer-related jobs were most frequently mentioned for both male and female children, twice as many adults thought these careers were more appropriate for men.

These anecdotes—a few among many reported by researchers, teachers, and parents—reflect something of the equity problems that persist in computer education today. With only slightly more than 40 thousand computers in the schools for more than 42 million students, questions of access still must be asked: how will we decide who has the opportunity to use computers? Who will learn programming and who will learn applications? And who will have the authority to make these decisions?

What is Access?

First and foremost, "access" means actual, physical access to computers, both in school and at home; it also means access to sufficient instruction and user time and to instruction that is free of biased assumptions about girls' preferences and abilities. Data about the availability of computers in the schools continue to show that urban, low-income, predominantly minority school districts have far fewer computers than do suburban, wealthier districts and that these few computers are most often used for drills and remediation in low-income schools. Further, boys still outnumber girls in high school programming classes, though there is some evidence that the gap may be narrowing; data from the 1984 National Assessment of Educational Progress indicate that 20.3 percent of the 13 year old males and 16.5 percent of the 13 year old females reported taking a computer class at least once per week. In 1980-82, 41 percent of the students in programming courses were female, while 59 percent were male.[2] But girls still predominate in business courses and applications (word processing, for example) preparing for careers in the "pink collar" clerical ghetto.

By the end of the 1980s, many of the simplest access problems may be solved, as more schools acquire computers. The nature of the equity problems then will be seen as more qualitative, focused on the availability of non-biased courseware to all students. But although the increase in the number of students using computers will give the appearance of "equal access," more subtle inequities in the treatment of students may remain. For example, students defined as "slower" may be limited to using only drill-and-practice software and may not be exposed to more sophisticated computer learning activities that have the potential to inspire greater achievement. Such differential treatment could easily reflect racial bias and perpetuate the current situation, in which minority students and students eligible for bilingual education use computers for learning in substantially smaller numbers.[3]

Applications Or Computer Programming?

A potential threat to full equity in computer education is the trend in public schools towards teaching applications rather than programming; while applications such as word processing and database management are invaluable, deeper knowledge about the computer's capability—and the user's ability to control it—is only available through programming. Currently, computers are used in three ways in the classroom: for drill exercises (a sort of mechanized teacher), as a tool (for word processing or data analysis in a variety of curriculum areas) or as a subject of study in itself (computer literacy and programming). Until recently the emphasis has been on developing "computer literacy" for all students; in fact, at this writing, twenty-six states and the District of Columbia have established guidelines for computer literacy. Although there is no universally accepted definition of computer literacy, these classes have included some basic instruction in programming and computer concepts.

Recently, however, some educators and researchers have discarded the goal of "computer literacy" for all students and have begun to argue that, while all students should be able to use the computer for various purposes, all students do *not* need to acquire the more "difficult," higher level programming skills. In fact, according to the "Second National Survey of Instructional Uses of School Computers," more applications uses are emerging in the schools—word-processing applications in English and business-education classes and drafting, diagramming, and calculating applications in vocational education classes.[4]

Whether computers should be used only in some specific curriculum areas or whether computers should be used in all grade levels for a variety of educational purposes also is part of this debate. Often overlooked is an underlying assumption (often unconscious and usually unstated) that some students (female and minority students and low-income students, for instance) need not be "pushed" to learn programming; instead, this reasoning goes, they will find knowledge of applications sufficient to compete for "appropriate" jobs in the technology-infused workplace of the future. It even has been suggested that the real "problem" is that girls and minority boys "dislike" programming and that the schools' shift in emphasis from programming to applications is therefore an appropriate solution to this "problem," as it at least brings these students into contact with educational technology in some form. But this approach automatically blocks these female and minority students from pursuing advanced pro-

gramming courses (and related careers) because they lack the necessary "basic" skills; clearly, the "more savvy students, mostly white and male," will continue to take programming.[5]

A commitment to equal access requires that such choices, between applications and programming, should not be made prematurely by any students and certainly should not be made for students based on their apparent lack of interest or sex-based stereotyping. Rather, educators and advocates alike should acknowledge that the most complete preparation available is essential, particularly for low-income students and those traditionally consigned to jobs in the blue collar and pink collar ghettoes.

This is a particularly important concern for parents and teachers today, as experts are far from agreement on what kinds of computer-related skills will be required for the worker of the future. Sheldon Rosenberg of the New York public schools, for example, put strong emphasis on applications, stating that "we are presently in a technological revolution whose applications involvement will have more impact on society in general than the internal combustion engine or the radio."[6] He further believes that "no matter what the student's career objectives may ultimately be, technology is now progressing so rapidly in our society that most workers will need to be able to interact with computers. Keyboarding skills and dialogue techniques will be vital for the worker of the future."[7]

In contrast, the National Commission on Employment Policy recently reported that "although computer use is widespread and growing rapidly, relatively few workers need extensive education or training in computer-related skills; most learn their skills in brief, on-the-job training. Young workers need not fear being frozen out of the job market because they have not learned about computers."[8] Some researchers also argue that learning computer programming is not only unnecessary for most students, but it also fails to teach the essential analytical and problem-solving skills. There is "little evidence to support the widely held view that learning to program will develop students' abilities to solve problems," according to a study by the Center for Research into Practice.[9] But the same report also offers a possible explanation, stating that most students in programming classes are not actually learning programming. Indeed, it is likely that the problem with teaching programming is in our pedagogy rather than in the nature or value of the subject matter.

It also is significant to note that, despite the public schools' new enthusiasm for computer applications instead of programming, private schools are pursuing the opposite course. According to a survey of 653 private schools conducted by the National Association of Independent Schools, private schools not only have more computers than public schools but they use them differently than do the public schools. The average annual tuition for the surveyed schools was $4,246 in 1984 and these private schools averaged 66 children per computer as opposed to 71 children per computer in the public schools. In addition, programming was taught at 86 percent of the schools, while only 26 percent used the computers for drill exercises and 44 percent used them for writing assignments. Eighty percent of the private schools surveyed taught computer literacy courses. In addition, 40 percent of the students had access to a home computer.[10] Clearly, these more affluent private schools perceive the need for computer programming knowledge for their student bodies, so applications and drill take a back seat to higher order computer instruction.

This provides additional support for the argument that learning applications without understanding theory and programming produces students with only superficial competence with the computer. "Schools that avoid teaching students to program are hiding from kids what computers really are and can do" and thus are limiting their future intellectual and employment options. "There is a body of knowledge about computers that is so important that every student should know it." Although only a small percentage of future workers will use programming expertise to perform their jobs, students who learn to use computers but not to program will rule out these computing careers and "have computer science excluded from their lives."[11]

And finally, "using an application program written by someone else may be easier than learning to write programs of one's own, but it would be foolish to claim that word processing skills, for example, are on the same intellectual level as programming skills. The first gives the student only minimal control over the computer and few basic ideas about it. Programming skills give complete control and deep ideas about computers."[12] Seymour Papert addresses the relationship between teaching and learning and points to new ways to conceptualize the learning process: "If programming does influence thinking, this influence must not be conceptualized as a direct consequence of learning to program. Fluency in programming provides an opportunity for teachers to teach in new ways and for students to learn in new ways."[13]

Computer science as taught in the public schools is still in its infancy. While more than half of all high schools now offer a course in computer science, less than one percent of all high school course enrollments are in computer science.[14] Further, most children average only minutes per week on the computer—23 minutes in elementary school and 45 minutes at the secondary school level—and computer instruction itself is often less than adequate. "Too many computer introduction courses or sessions focus the teacher too narrowly on specific topics or uses. Consequently their students then learn to view the computer as a way to do a specific task, or learn a certain skill, and not as a way to stretch their minds to become real problem solvers."[15]

The end result is that "most children are simply not getting an opportunity to become familiar with

the computer as a powerful entity they can control."[16] Only an elite few—generally white, affluent and male students—have the opportunity to truly gain mastery over the computer. This pattern is linked to mathematics and science education, as well; in "High School and Beyond," the National Center for Education Statistics reported that participation in computer science was commonly related to more intense participation in mathematics and science. Overall, white students take more mathematics, science and computer science than Black and Hispanic students and males tend to concentrate more in science, including computer science, than do females.[17]

Breaking the Programming Barrier

Various strategies for luring the reluctant female student to computer education have been proposed. For example, some have suggested that girls are more interested in the computer as a tool and therefore gravitate to activities that are perceived as relevant to future occupations—such as word processing, drawing, and sending and receiving mail. Based on this theory, which is itself grounded in stereotypes about occupations that are suitable for women, some educators believe that schools should encourage girls to take computer-based courses by offering them the practical, computer applications courses, without "troubling" them with more difficult programming courses. Once again, however, it is clear that those young women whose only exposure to the computer centers on practical applications are also learning some very traditional sex-role stereotypes about their futures; put bluntly, this strategy for interesting girls in computers may lead schools to offer "programming for boys and word processing for girls," rather than programming *and* applications for both boys and girls.[18] Allowing female students to limit their computer education to word processing is similar to allowing girls to fulfill high school mathematics requirements by taking only general and business math. In both cases, schools would be encouraging the perpetuation of stereotyped behavior already learned by young women by the time they reach junior high school; rather schools should be encouraging young women to expand their horizons, and even to "reach for the stars."

After all, girls apparently do not need to be encouraged to take word processing, but they do need to be encouraged to enroll in programming. Indeed, a recent study found evidence that the impact of sex stereotyped assumptions about "women's work" affects high school students: after one computer course in high school, 52 percent of the young women expressed interest in taking more word processing and business applications, while 59 percent of the young men were interested in more programming.[19] Even more telling were the comments of fourth through twelfth grade girls who, when asked what they saw themselves doing with the computer at age 30, said "housework" while boys of the same age said "finances, data processing, and games."[20]

Indeed, there is some evidence that girls substantially increased their participation in computer-related courses when they were encouraged to do so.[21] Other research indicates that young women's attitudes towards the computer became more positive as their participation in computer courses increased. Girls who enroll in computer science courses generally have a positive view of the value of computer education; 80 percent of girls enrolled in a mandatory high school computer science course agreed that knowing about computers would be important for their future lives.[22]

Computer education for minority and low-income students, particularly young women, is even more severely restricted, largely because stereotyped attitudes such as those described above are combined with even more limited resources (in low-income communities) and the more limited uses to which the available computers are put in these schools. According to recent data from the National Assessment of Educational Progress, approximately 25 percent of both Black and white students report using a computer in school at least once a week, as do 17 percent of Hispanic students;[23] but these data may be misleading, as the studies do not show whether the students were using the computer for remediation (drill and practice, for instance), learning new applications (database management, for example), or for advanced programming. And yet substantial evidence exists that in schools in lower income communities, the chances are that "computer literacy takes a back seat to basic literacy. Most computer instruction is drill and practice in such limited functions as data and word processing."[24] According to the director of a Harlem-based computer equity program, "in schools with only four or five computers, the computers are reserved for either the gifted students or for those who need remediation. Very few are used for the kids in between."[25]

This focus on remediation for low-income students is reflected in the ambitious program recently established in a Texas school district: in order to deal with teacher shortages and improve student scores on state achievement tests, the district purchased six new computer labs for remedial classes, for students eligible for federal Chapter I (disadvantaged) and migrant education programs.[26] In fact, many teachers in schools with substantial minority enrollments "focus a great deal of their attention on seeing that students are able to pass a minimal competency test, which tends to severely limit the time available and motivation for more advanced study."[27] Given such findings, it is hardly surprising that the California Assessment Program of 1983 found that socio-economic status was significantly related to performance with computers.[28]

In fact, the historical pattern of unequal treatment of low-income and predominantly minority schools is repeated in the new field of computer education; the schools that could benefit the most from access to improved equipment, curriculum, and teachers often receive the least. And this seems to remain

the case in those curriculum areas usually defined as critical for the "high-tech" future—math, science, and computer education. For example, at a school with high minority enrollment and achievement test scores in the 37th percentile nationally, there had not been a teacher whose college major was mathematics in twenty years. In contrast, at a school with low minority enrollment and achievement test scores in the 98th percentile, *all* of the mathematics teachers had been mathematics majors in college and averaged ten years of teaching experience. Clearly, the availability of these human resources contributed to the students' higher achievement test scores; further research is needed to assess the impact on achievement of computer resources as well.[29]

Female and minority students are also much less likely to participate in extracurricular activities involving computers or to attend computer camps. Three out of four computer campers are boys, and they are almost exclusively white.[30] According to the 1984 National Assessment of Educational Progress, 31 percent of 13 year old males and 25 percent of females reported using computers on a weekly basis during extracurricular times outside of the regular school day;[31] further, school-based computer centers are used primarily by boys, with male to female ratios ranging from 20:1 to 3:2.[32] Finally, many inner city schools restrict students' access to the computers after school because of security concerns. At DuSable School in Chicago, for example, the school's computers are "cordoned off in a third-floor room behind steel-reinforced doors with extra dead-bolt locks, so kids can't use them after school or on weekends."[33]

The Next Equity Frontier: Computers in the Home

Although access to computers in schools is necessary, it clearly is not sufficient; access to the computer for a few minutes each week is not enough—women and minority men also need access to information, to knowledge, and to a sense of their own ability to manipulate and control both the technology and their own lives in this society. A key to equal access can be found in the studies showing that children who have computers at home have a substantial advantage over those who do not. Children—both boys and girls—understand computers better if they have been taught computer programming outside of school or if their friends or their mothers use computers.[34] Yet today there are only five million computers in 27 million homes of 42 million school-aged children—one for every five or six students. And most of these computers are in the most affluent homes.[35]

Several studies have found that students who have access to computers at home have more positive attitudes toward them. A study of all students in grades three and four in an upper-middle class school district found that a higher proportion of those students who had computers at home expressed comfort with the computer than did non-owners.[36] Another study found that junior high school students who owned computers engaged in more extracurricular computer use, were more likely to plan to take courses in programming in high school, and were more interested in learning about a computer-related career than were students who did not own computers.[37]

Indeed, it would be difficult to overestimate the importance of home computer experience. A recent study conducted by Margot Ely of the New York University School of Education, Health, Nursing and Arts Professions, found that having a home computer significantly improved low-income, minority children's educational skills and enthusiasm for learning. Twenty-two participants in a summer camp in 1984 used computers only in the camp's classrooms, while fourteen were also given computers to use at home. The students with computers at home described a greater increase in "feelings of accomplishment and esteem" and in "awareness of themselves as students and as people with responsibility toward others." Their parents also were enthusiastic about the impact of the computers, because their children's learning increased, their attitude toward school improved, and they used their time at home more creatively.[38]

Yet all available data indicate that children from low-income communities are the least likely of all children to have computers at school or at home. And these children are most likely to be Black or Hispanic or to be living in households with a single, female parent. Carol Edwards of the Southern Coalition for Educational Equity has clearly shown how minority children are excluded from access to computers; she points out that southern and western states with the highest concentrations of Black and Hispanic residents also have the lowest computer-to-student ratios in the country. In addition, the average annual income of families with home computers is between $35,000 and $40,000; but the median income for Black families, according to the 1980 Census, is less than $20,000; and Black women who are the sole heads of their households earn less than $8,000 per year.

According to the National Commission on Employment Policy, educational use of the computer at home is rapidly approaching more common entertainment uses. Thus, even if low-income, minority and female students had equal access to computers at schools—their lack of home computers, in comparison to their more affluent white brothers, threatens to increase the achievement gap between middle and lower income groups.[39]

The Shoreham-Wading River School District on Long Island has developed an innovative alternative to putting microcomputers in the schools; instead, the school district is giving a computer to each child and teacher to take home. Teachers will use their computers to plan activities and to communicate with students, while students will have more time to practice, do homework, and experiment with the computer.[40]

While owning a home computer is a key to major inequities based on economic status, data also show that parents tend to buy computers for their sons more often than for their daughters. The National Assessment of Educational Progress (1984) found that a higher proportion of 13 year old males (38 percent) than females (26 percent) reported having a computer at home.[41] And among entering freshmen at the University of California at Berkeley, twice as many men as women have a computer at home or have written a computer program.[42]

In addition, when there is a computer in the home, men appear to dominate in both selecting the computer and using it; while 45 percent of the new cars sold in 1982 were purchased by women, only 2 percent of the computers were.[43] And according to a 1984 *USA Today* survey, 70 percent of the main users of home computers are male.[44] A study of children enrolled in a computer camp found that 71 percent of the males but only 43 percent of the females used a computer at home, even though there was no sex difference in family ownership of a computer. [45] Finally, a 1983 study of Kentucky students participating in a computer programming contest found that 51 percent of the boys had a home computer, contrasted with 31 percent of the girls.[46]

Learning Her Place: Sex Bias and Cognitive Styles

Many possible explanations have been offered for sex differences in performance and participation in computer use, including sex stereotyped career expectations, less parental support and encouragement, and discouraging advertising (particularly on television, where computers often are "pitched" to boys and their fathers); other explanations include the dearth of women as role models in computer-related careers, the impact of negative peer pressure—as well as outright discrimination against girls in programming classes. One rather disconcerting explanation that is gaining some currency is that girls and boys are innately "different" intellectually, that they have different abilities and cognitive learning styles. For example, a recent study found that high school girls obtained higher scores on a test of programming skills, while boys and girls scored equally on a test of "computer literacy." These findings, however, which appear to indicate that high school girls are "better" at programming than are their male counterparts, have been interpreted to suggest that women may be "better" at programming because "women tend to be better than men at following explicit instructions, which may make them better at understanding the nature and structure of computer programming. Boys are stronger in strategic thinking and better at reading flow charts and in solving mathematics problems."[47]

These are extremely dangerous conclusions, relying as they do on stereotypic views of "feminine" versus "masculine" thinking and learning styles (which certainly have not been proved to be inevitable) and implying that the "masculine" ability is more valuable—men's "strategic thinking" versus women's "following explicit instructions." The real issue here is not which sex excels at which task or style of thinking but rather which style of thinking is *valued*.

All too often we find that those talents defined as "male" are, by definition, more highly valued by both school and society. Parents, teachers, and researchers must be extremely careful of these assumptions and of what they imply about "free choice" and "aptitude" and "lack of interest" in computers on the part of girls. Much recent research and anecdotal data indicate that girls learn which preferences are "appropriate" for them through a variety of media; they see advertising for computers and for both educational and recreational software, for example, that tells them: "this is for boys." Their parents send their brothers to computer camps in far larger numbers and purchase home computers for their sons more often than for their daughters.

And girls receive different messages and treatment in many classrooms. A recent PEER Report, *Learning Her Place: Sex Bias in the Elementary School Classroom*,[48] found that the "classroom climate continues to be heavily influenced by sexism and racism, often despite the good intentions of dedicated teachers." The analysis of the research on classroom interactions conducted during the past ten years found that girls still are perceived more favorably, disciplined less harshly, and graded more generously than boys, but boys receive more attention, encouragement, and constructive criticism. Boys emerge from this environment ready to move ahead and surpass their female classmates. Girls bring to their further education and their career plans a habit of playing it safe and a collection of nagging doubts about their own abilities which often persist in contradiction to their exceptional grades. And because girls also are less likely to have computers available to them at home and in school and are less likely to be sent to computer camps by their parents, is it any wonder that they do not "choose" to take the courses of study deemed "non-traditional"? Is it any wonder that their self-esteem and ambition suffer?

A recent article in *USA Today*[49] reported the results of a survey of female and male high school valedictorians and honor students; they were asked to rate their own intellectual abilities. The young women's estimates of their abilities were significantly lower than the men's after less than two years in college, even though they were successful in college and often had earned higher grade-point averages than had their male counterparts. In fact, as high school seniors 23 percent of the men and 21 percent of the women had rated themselves as "far above average" in intelligence. As college sophomores, 22 percent of the men still graded themselves that highly, but only four percent of the women did.

Educational and Occupational Segregation: "Women's Work" in the 1980s

High school vocational education programs, where students train for specific occupations, remain largely segregated both by sex and by race. Women comprise only 13 percent of the enrollment in programs that have traditionally been dominated by men—including technical fields. Of the students completing a vocational program in computer and information science in 1984, 82 percent were white—but only 63 percent of the students in vocational home economics were white. Female students are only 13 percent of the completers in engineering (10 percent are white, .6 percent Hispanic and 1.5 percent Black), but are nearly 90 percent of the completers in allied health professions.[50]

Segregation in schools is reflected in segregation in the job market. According to the National Academy of Sciences, half of all Americans work in jobs that are 80 percent male or female. Although jobs became less segregated during the 1970s, this process has slowed in the 1980s.[51] Of 503 separate, detailed job categories listed by the Bureau of Labor Statistics, five of the top ten occupations employing women are in sales and clerical work—secretaries, bookkeepers, cashiers, salesworkers and typists. Forty-two percent of employed women are employed in sales occupations or in administrative support occupations, 19 percent are in service occupations, 22 percent are in management and professional occupations.[52] Further, while women are 52 percent of the population, they are only 10 percent of scientists and engineers; and while minorities represent approximately 18 percent of the population, they are only two percent of the scientists and engineers.[53]

A recent report from the Office of Technology Assessment found that women scientists and engineers generally receive lower salaries and have a smaller chance of promotion than men. The report comments that this "differential treatment" has a "significant discouraging effect on female students in the educational pipeline."[54] Although men and women engineers, for example, report comparable levels of technical responsibility commensurate with their years of experience, a larger percentage of men than women engineers have managerial and professional supervisory responsibilities. And women engineers still tend to earn less than their male colleagues.[55]

The number of women who hold bachelors degrees in engineering has increased from 744 in 1974 to 10,761 in 1984.[56] But, after a decade of growth in the number of women in the engineering profession, the percentage of women engineering freshmen has fallen from 17.1 percent in the fall of 1983 to 16.5 percent in 1984. Black enrollments in engineering peaked in 1982 and have declined by more than 12 percent in the past three years; Hispanic enrollments increased slightly in 1984.[57]

According to a 1983 survey of members of the American Institute of Physics, only a small percentage of Institute members were women—less than five percent of the Ph.D.s. And the women were more likely to work for secondary schools and nonprofit organizations and were less likely to be employed by industry and the national laboratories. Salary level differences between men and women range from 11 to 28 percent.[58]

The Labor Department reports that in the category of computer systems analyst—the fastest growing and highest paid computer-related job—women hold 30 percent of the jobs, Blacks hold 5.3 percent, and Hispanics 1.8 percent. Further, among computer systems analysts the percentage of women increased to 30 percent in 1984 from 27.8 percent in 1983; during that same period, the percentage of Black and Hispanic computer systems analysts dropped to 7.1 percent from 8.9 percent.[59]

In the early days of the computer industry (1960), when there were only 2,000 computer operators, 65 percent of them were women. But twenty years later, in 1980, 59 percent of the computer operators, 31 percent of the computer programmers, and 22 percent of the systems analysts were women; in 1982, women earned 34 percent of the undergraduate degrees awarded in computer science.[60]

The Jobs of The Future: Where Will Women Be?

By 1995, women are expected to represent 46 percent of the labor force—up from 40 percent in 1970;[61] and participation among women ages 25 to 44 is expected to exceed 80 percent in 1995, up from 70 percent in 1970.[62] Women and minority men are expected to comprise the largest share of new workers during the next ten years, largely because of the decline in the white birth-rate and the aging of the general population.[63] In addition, substantial changes have occurred in women's attitudes; women today clearly identify themselves as workers and understand the importance of their work to their families; a *New York Times* poll conducted late in 1983 found that "more than ever, American women think their place is on the job."[64]

As women's participation in the labor force is increasing, the number of women who are raising a family alone—often in poverty—also is increasing. Demographers project that the number of families whose sole head is a woman will increase at a rate five times that of two-parent families over the next few years.[65] During the past twenty years, the number of households headed solely by women has more than doubled, from 4.4 million in 1960 to 9.4 million in 1981,[66] and these families are increasingly likely to live in poverty. In 1981, 70 percent of poor Black families, 50 percent of poor Hispanic families and 39 percent of poor white families were maintained solely by women. Among them, these families included seven million child-

ren. And evidence from various sources, including the Institute for Policy Studies' Women's Economic Agenda Working Group, indicates that, once they are poor, women and their families are much more likely to remain poor than are men.[67]

In part because of continuing job segregation, which results in women's concentration in a relatively small number of the lowest paid occupations, wages for full-time working women still average only 60 percent of those earned by white men—an actual decline since the 1950s. For women of color, the gap is even greater: Hispanic women earn 52 percent and Black women earn 56 percent of white male earnings. The impact of race and sex discrimination on women of color is perhaps most clearly portrayed in the following data from the report of the Women's Economic Agenda Working Group: *the poverty rate for Black mothers working full-time is the same as that of white men who do not work at all.*

The education offered to today's girls will substantially affect their ability to provide for themselves and their families and to avoid falling into poverty; indeed, the more education an individual has, the less likely she/he is to live in poverty. In 1981, the poverty rate was 49 percent for those with less than eight years of education, 27.8 percent for high school graduates and 16 percent for those with one or more years of college.[68]

Labor force trends tend to indicate continued job segregation into the next decade. While demographers and futurists disagree about the nature of the job market in the twenty-first century, it is likely that the explosive impact of technology on the job market will leave women concentrated in lower paying jobs in the service sector or in the jobs at the lowest end of the pay scale in high-technology industries. Some demographers suggest that up to ninety percent of the new jobs that will be created by 1995 will be in service-producing industries, such as transportation, communications, public utilities, trade, finance, insurance, real estate, and government; the bulk of these new jobs are likely to be in the business service sector, which is expected to account for more than one out of four jobs by 1995.[69] In addition, clerical occupations that traditionally have been the key "pink collar ghetto" jobs for women are being transformed (and their numbers reduced) by computer-related technologies; typists thus become word processor operators and, as more offices are automated, fewer clerical support workers are needed to perform the same duties.

The computer and other technological advances also have led to a demand for programming and software services and for a whole range of consulting and management services.[70] Presently there are about 7,500,000 computers in use in virtually every industry. About one percent of all workers (800,000) currently need extensive special computer-related education or training, according to a recent report by the National Commission for Employment Policy. Some industry experts believe that there will be continued "explosive" growth in the demand for computer and data processing services over the next decade; these experts, disagreeing somewhat with those who believe the service-producing sector will experience the greatest growth, instead believe that these "high-tech" industries will be the fastest-growing of all. Further, most of the growth probably will be in those fields—commanding both higher pay and higher status—where women and minority males are vastly underrepresented: programming and software services. There will be a lesser increase in fields where women dominate, such as those requiring computer applications (data processing occupations) because current clerical personnel will be trained to perform routine processing.

But the infusion of technology into a number of industries—in manufacturing, communications, design, and engineering, for instance—will require personnel who are trained to develop new software or who are adept in high-level programming languages.[71] Further, the new technologies available now are expected to become more widespread. For example, robotics will play an increasingly important role in American industry over the next ten years, displacing some four percent of the workforce while creating nearly 50,000 robotics-related jobs ranging from maintenance workers to programmers.[72] In fact, although the outlook for employment in the manufacturing industry is somewhat bleak—with little or no growth overall—the computer manufacturing and electronic components industries, which were the growth leaders between 1959 and 1984, probably will remain so throughout the next decade.[73]

In addition to increased computerization overall, there is a trend toward more and more part-time work. In 1982, one out of every five American workers was employed part-time and some studies have predicted that half of all jobs will be part-time by the year 2000.[74] Women are nearly three times more likely than men to work part-time,[75] and part-time workers seldom receive the benefits provided to many full-time workers, such as paid vacations, health insurance, or pensions. Further, on an hour for hour basis, part-time workers earn less than full time workers: in 1982, they earned an average of $3.88 an hour, compared to an average of $6.44 for full-time workers.[76]

Another workforce trend that will affect women's work is the trend towards computer-based "home work"—often touted as a "solution" for the working mother's need to combine gainful employment with her child-rearing responsibilities.[77] While the notion that women can work at home and therefore take care of their children is seen as appealing by many, it simply replicates the lowest rungs of the career ladder in the "pink collar ghetto" while perpetuating the notion that women must be the primary caretakers of children and thus restrict their roles in the workforce. Indeed, women working on computers at home are likely to be low paid data entry clerks; in contrast, men working on computers at home are likely to be executives communicating important documents to their offices. While she earns minimum wage and receives no benefits, he continues to earn his executive salary and benefits.

Avoiding The Star Trek Future

The data and research reported here indicate that the Star Trek future is closer than we think. Already the computer is transforming the way we work and play; a new computer program, for example, can play and win at chess—and fool a chess master into thinking it is human.[78] Students now use computer synthesizers to compose and edit music and learn foreign languages.[79] Another program analyzes grammar, punctuation, organization, weak phrasing, vague wording and sexist usage in poetry, fiction and essays and even suggests improvements.[80] And nursing students are learning to nurse using computer simulations of patients rather than the real thing.[81] As both a teaching tool and subject of study from pre-school through graduate school, the computer's potential is just beginning to be tapped.[82]

Computers and computer-related technology have just begun to touch on our lives and already great changes have been made in the workplace. Over the next decade and into the future these changes will be multiplied tenfold. But without a conscious effort on the part of policymakers and leaders in both industry and education, many women and persons of color will retain their positions at the lowest end of their career ladders, becoming the "technopeasants" of the high-tech workforce.

Whether women are employed as secretaries or word processors, hairdressers or child care workers, teachers or nurses, as they are today, or whether they are computer repair technicians or programmers, bankers or government executives, they certainly will use computer technology in their work, perhaps in ways we cannot yet imagine. If they have only learned computer applications such as word processing during their school years, they will not be prepared to control this technology and thus have access to the highest level careers managing technological change.

Because the future remains unknown, it is critical that even those young women and minority men who will not be programmers or systems analysts learn the newest "basic skill" of programming. Further, women and persons of color, who traditionally have been excluded from most positions of power, must participate in decisionmaking about the appropriate and ethical uses of technology; and for that, they must know that they can control the technology and need not be contolled by it.

The schools must take the lead in ensuring that all students share equally in educational technology—learning not only how to use computers for simple drill and practice but also for advanced applications and programming. Thus, equal access for women and minority men through education will enable them to participate as adults in the "technology elite"—currently made up primarily of white male engineers and computer scientists—who design new hardware, write new programs, develop new systems and applications, and help decide how technology will impact society.

The Role of the Schools: Recommendations

To avoid the Star Trek future and create our vision of an egalitarian one instead, PEER recommends three immediate steps:

- Computer literacy instruction should be required for all students and should include programming, applications, and discussions of the political and ethical issues surrounding the uses of technology.
- All students should have equal access to computers both at home and in school. School districts, particularly in low-income communities, should develop mechanisms for providing computers to children whose parents cannot afford them and should focus particularly on those students generally considered to "dislike" computers—girls and minority boys.

Various strategies could achieve this goal, from simply giving each child a computer (admittedly, an expensive proposition for most school districts) to establishing a "lending" library of home computers for use by low-income students. Further, local educational leaders and parents can unite to encourage the development of state and federal government programs—ranging from tax incentives to a direct grant program—that would ensure that every low-income student has access to a home computer. Finally, school-business partnerships can be developed to provide both hardware and software—as well as expertise and role models from business—to low-income students and their teachers.

- To overcome the effects of sex and race stereotyped assumptions and behaviors, schools also should[83] provide students with opportunities for extracurricular experiences with basic concepts of mathematics and science and with computers; hands-on activities in science and assignment of "gender neutral" tasks should be available. Further, teachers can reorganize their classrooms to permit and encourage peer learning and can use existing enrichment materials and career education programs to encourage female and minority students to believe in their own competence in mathematics, science and technology and in the possibility of future careers in these fields.[84]

Where No One Has Gone Before ... The Egalitarian Future

Computers and technology offer us a way to break down stereotyping and bias in jobs and in schools, as a computer does not make inherently racist or sexist assumptions or treat students differently on the basis of race or sex or economic status. In the midst of the technological change that is transforming our society, we must consider how to also transform the damaging patterns of sex and race segregation and stereotyping in our schools and in our workplace. Otherwise, our daughters' futures will resemble Star Trek re-runs. Moving toward the twenty-first century, parents and educa-

tors must concentrate their efforts on creating a truly egalitarian social structure, beginning with their own backyards—their schools and corporations and homes—and continuing with efforts to change federal and state policies. Young girls need our help to take them—to paraphrase Star Trek—"where no woman has gone before!"

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This report was produced in part under a grant from the U.S. Education Department, under the auspices of the Women's Educational Equity Act. Opinions expressed herein do not necessarily reflect the position or policy of the Department, and no official endorsement should be inferred.

Beyond the Star Trek Syndrome to an Egalitarian Future: "Where No One Has Gone Before"

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PEER, the Project on Equal Education Rights of the NOW Legal Defense and Education Fund, is one of the leading national advocacy programs for educational equity for women and girls of all racial and ethnic groups, both disabled and non-disabled. PEER's National Affiliate Network links activists and educators in a national community of concern for the advancement of women and girls.

Created in 1974, PEER has received support from various sources, including the Carnegie Corporation, the Ford Foundation, the Charles Stewart Mott Foundation, the Rockefeller Family Fund, several corporations, and the Women's Educational Equity Act Program, U.S. Department of Education.

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